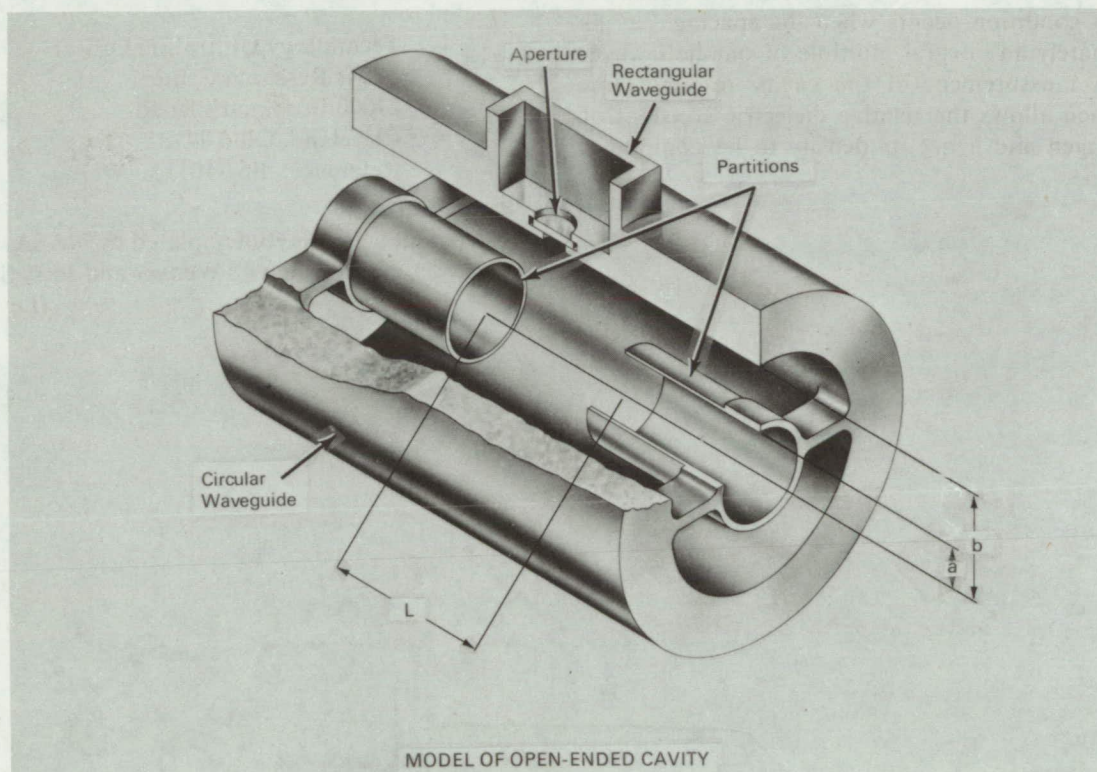


NASA TECH BRIEF



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Liquid Hydrogen Densitometer Utilizes Open-Ended Microwave Cavity



The problem:

To develop a method for the direct measurement of the density of flowing liquid, gaseous, or two-phase hydrogen.

The solution:

Microwave cavities have been used for many years to measure the densities of fluids and gases. The shift in the resonant frequency when a fluid is introduced

into an evacuated microwave cavity gives a measure of the dielectric constant of the fluid. The density of the fluid can then be determined from the dielectric constant data by using either a suitable theory on electric polarization for that particular fluid or an empirical or experimentally obtained formula. An open-ended microwave cavity has recently been developed to measure the density of flowing liquid, gaseous, or two-phase hydrogen. The operation of the cavity is based

(continued overleaf)

on derived relations between the cavity resonant frequency, the dielectric constant of hydrogen, and the density of hydrogen.

How it's done:

The cavity consists of a circular waveguide of radius "b" that is terminated at each end with thin coaxial cylindrical partitions of radius "a" that are separated by a distance "L". Because the partitions are extremely thin, they offer little resistance to the flow of hydrogen through the cavity. Microwave energy is supplied to the cavity through the small aperture in the side wall. If the cylindrical partitions are sufficiently long, they will act as perfect reflectors to the microwave energy over a frequency range whose limits are dependent on the dimensions "a" and "b". The cavity is resonant when the spacing between the partitions is adjusted so that the reflections are constructive. This condition occurs when the spacing "L" is approximately an integral multiple of one-half wavelength. A measurement of the cavity resonant frequency then allows the relative dielectric constant of the hydrogen and hence its density to be computed.

Notes:

1. Hydrogen density measurements that were made by using this open-ended microwave cavity were in excellent agreement with density calculations that were based on pressure-temperature data. Accurate density measurements can also be taken for two-phase hydrogen if the hydrogen gas bubbles can be reduced sufficiently in size and distributed uniformly in the liquid.
2. Additional technical details are contained in: "Liquid Hydrogen Density Measurements Using an Open Ended Microwave Cavity," by Norman C. Wenger and Jerry Smetana, NASA TN D-3680, October 1966, available from the Clearinghouse for Scientific and Technical Information, Springfield, Virginia 22151, price \$1.00.
3. Inquiries concerning this innovation may be directed to:

Technology Utilization Officer
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Reference: B67-10115

Patent status:

No patent action is contemplated by NASA.

Source: Norman C. Wenger and Jerry Smetana
(Lewis-390)